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OFFICE OF
PREVENTION, PESTICIDES
AND
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Memorandum

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SUBJECT: Biological and Economic Analysis of Diazinon on Strawberries
Impacts of Cancellation

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SUMMARY

Diazinon is primarily used in strawberries to help control a variety of foliar and fruit feeding insect

pests. The highest use of diazinon in this crop occurs in California and Florida, which are also the largest producers of strawberries. The major targets of diazinon applications are all foliar feeding insects: aphids and *Lygus* bugs in California, and a complex of caterpillar species in Florida. Alternatives should provide adequate control, albeit at higher costs. However, most alternatives have limitations such as phytotoxicity or killing beneficial predatory mites. Of greatest concern is the strong possibility that the key pests involved may develop resistance to the most effective and least problematic alternatives, the synthetic pyrethroids and spinosad. Such resistance has already been demonstrated by these insects in other crops grown in California and Florida. BEAD believes that loss of diazinon as a component of pest management in this crop system could result in resistance developing faster in these insects. If resistance develops in all of these pests, some growers could face significant losses. Given the presence of resistant populations near strawberries, BEAD believes that this outcome could occur in the timeframe considered in this assessment.

Economic analysis of the most likely scenarios involving the use of the most practical and effective alternatives available indicates that production costs would increase by more than $60/acre in both states. This would result in a decrease in net cash returns of 3.5 % in California and about one percent in Florida. Diazinon is used on about 3,300 acres in California and 700 acres in Florida. Industry level losses from a cancellation could therefore be over $200,000 in California and almost $50,000 in Florida, representing around 0.02 % of gross revenues in both states.

LIMITATIONS AND SCOPE OF ANALYSIS

The scope of this analysis includes an examination of potential regional-level impacts associated with elimination (through a phase-out) of the use of diazinon on strawberries. This mitigation scenario is in response to the high health risks to mixers, loaders and applicators as identified by the Health Effects Division of the Office of Pesticide Programs. This analysis does not attempt to address impacts associated with mitigation efforts targeted at workers reentering fields treated with diazinon, or potential mitigation for various environmental risks (i.e., risk mitigation for risks to terrestrial plants and organisms or water contamination).

There are limitations to this assessment. The impacts estimated by this analysis only represent potential short-term – 1 to 2 years – impacts on the strawberry production system. Assumptions about yield and quality losses associated with the various scenarios are based on the best professional judgement of BEAD analysts when estimates were not available from other sources. The basis for these assumptions is knowledge acquired from reviewing available USDA crop profiles, state crop production guides, discussions with university extension and research entomologists knowledgeable in strawberry production, and other sources listed. Production of strawberries is a very complex system that can be affected by many parameters (e.g., weather). BEAD's ability to quantitatively capture the wide array of events that could unfold given each hypothetical scenario listed above is very limited.

Economic analysis is based on crop budgets prepared by university extension specialists, which do not always include the exact combination of pesticides considered in BEAD's scenarios. Per-acre impacts are only broadly representative of grower impacts since the area infested by a pest or treated with diazinon may be less than a grower's entire acreage. State level impacts are calculated by simply scaling up the per-acre impacts. We ignore potential changes in price that may result from production changes and we assume that grower impacts will not result in a shift from cabbage to other crops.

CROP PRODUCTION

Strawberry production is a $1.1 billion per year industry in the U.S. (USDA 2002). Table 1 provides summary statistics for the major states and regions. California leads the nation in production with over 1.5 billion pounds annually, over 80% of total production. Florida contributes another 10%, which comprises nearly the entire winter season production. About 75% of total production goes to the fresh market, including nearly all production in Florida, the East and most Midwestern states. Over 90% of production from the Pacific Northwest, however, goes to the frozen market. California production is divided between fresh, 75% by weight, and processed, 25%. Michigan also sends about 20% of its production to processing.

Table 1. Acreage, production and value of strawberries, 1998-2000.

State/Region	Harvested Acres	Production (1000 lbs)	% of Total Production	Value ($1000)
California[1]	48,100	1,516,500	83.4	861,696
Florida[2]	6,300	191,800	10.5	161,850
Pacific Northwest[3]	5,100	52,700	2.9	25,052
East[4]	5,000	35,400	1.9	32,084
Midwest[5]	3,200	16,800	0.9	15,535
Other[6]	600	5,600	0.3	5,252
U.S.	46,800	1,818,700		1,101,469

Source: USDA/NASS, 2002

1 California Department of Pesticide Regulation. BEAD believes that USDA/NASS underestimate California acreage.
2 Florida is the principal source of winter season strawberries.
3 Washington and Oregon.
4 Mainly New Jersey, New York, North Carolina and Pennsylvania.
5 Mainly Michigan, Ohio and Wisconsin.
6 Includes Arkansas, Louisiana, Virginia and other states not listed separately.

The U.S. also imported over 80,000 metric tons (MT) of fresh or frozen strawberries in 1999 and nearly 70,000 MT in 2000 (USDA/ERS, 2002). Over 90% of imports come from Mexico. Data do not separate strawberries from other berries for exports. Canada is the primary importer of U.S. berries.

DIAZINON USAGE ON STRAWBERRIES

According to BEAD (2000), diazinon usage on strawberries between 1987 and 1997 was about 8,000 lbs active ingredient (a.i.) applied to around 4,000 acres every year. This represented approximately 9% of the cultivated acreage. For 2000, USDA/NASS (2001) reports that about 3,100 lbs of diazinon was applied to about 2,400 acres in the U.S. in 2000 (see Table 2). This represents about 5% of the crop area in surveyed states, which comprise nearly all the producing areas. Florida is the primary user of diazinon, applying a total of about 1,500 lbs a.i. Florida growers treat about 11% of their acreage and, on average, make two applications per year. USDA reports much less usage in California, with only about 2% of the crop area treated. Unfortunately, USDA does not separately report several key states.

Table 2. Reported usage of diazinon on strawberries, 2000.

State/Region	Planted Acres	% Crop Treated	Acres Treated	lbs. a.i. Applied	Rate (lbs ai./acre/year)
California	27,600	2	640	800	1.25
Florida	6,300	11	690	1,500	2.17
Michigan	1,400	5	70	50	0.71
Other reporting states[1]	8,100	12	970	750	0.77
States reporting no use[2]	4,000	0	0	0	
U.S. (reporting)	47,400	5	2,370	3,100	1.31

Source: USDA/NASS, 2001.

1 Pennsylvania, Oregon, Washington and Wisconsin.

2 New Jersey, New York and North Carolina.

However, the California Environmental Protection Agency reports significantly higher numbers for all columns (2002). This source indicates about 3,300 acres are treated annually in California, representing 6.6 % of 56,300 acres grown. Total applications are reported to be 3,700 lbs a.i. annually, more than USDA reports for the entire U.S. Combined with data from other sources, BEAD believes total usage for the U.S. at about 6,000 lbs a.i. applied annually to 5,000 acres, or about 7 % of the total area cultivated in strawberries (Table 3). In making this projection, BEAD assumes that neighboring states are representative of usage in states that do not report chemical usage. This suggests that application rates of diazinon on strawberries have declined, even while the area treated has increased in proportion to the expansion of cultivation over the past decade.

In all growing regions, the Wettable Powder (WP) formulation of diazinon is preferred and recommended, and ground application methods are most common (Aerts, Sharp, Sorensen, Isaacs, personal communication).

Table 3. Projected usage of diazinon on strawberries, 2000.

State/Region	Planted Acres	% Crop Treated	Acres Treated	lbs. a.i. Applied	Rate (lbs ai./acre/year)
California	56,300	7	3,300	3,700	1.12
Florida	6,300	11	700	1,500	2.17
Pacific Northwest[1]	5,000	17	900	400	0.77
East[2]	5,000	2	100	100	0.77
Midwest[3]	3,200	5	200	100	0.83
Other[4]	600	0	0	0	
U.S. (estimated)	69,600	7	5,000	6,000	1.19

Source: USDA/NASS, 2001, California EPA, 2002, NCFAP, 2002, EPA data. Columns may not sum due to rounding.

1 Washington and Oregon.

2 Mainly New Jersey, New York, North Carolina and Pennsylvania.

3 Mainly Michigan, Ohio and Wisconsin.

4 Includes Arkansas, Louisiana, Virginia and other states not listed separately.

INSECT PESTS TARGETED BY DIAZINON, AND POTENTIAL ALTERNATIVES

Diazinon is registered for use against many foliar feeding insects in all strawberry growing regions. However, only a few of these are considered important targets of current diazinon use. In California, a complex of aphid species (consisting of the strawberry aphid, green peach aphid, melon aphid, and potato aphid), and *Lygus* bugs (mainly *Lygus hesperus and L. lineolaris*) are the main targets (USDA 1999a, Zalom et al. 2001). All aphids are capable of transmitting a variety of viral diseases between plants, and so they are considered particularly harmful to strawberries being grown for transplantation. California produces a significant amount of the root stock used as the basis for crops in other states and countries, so production of disease free nursery plants is considered a priority (USDA 1999). *Lygus* bugs damage strawberry fruit by puncturing individual seeds early in their development. This eventually results in irregularly shaped, “cat-faced” berries, which can render fruit unmarketable (Allen and Gaede 1963). These insects are highly mobile, feed on a variety of other cultivated plants, and often migrate into strawberry fields from surrounding vegetation and crops (Zalom et al. 2001). While BEAD could not find published studies of yield losses attributable to *Lygus* damage, one crop expert from California estimated that as much as 35% of the harvest could be lost if no insecticides at all were available to control this insect

(Zalom, personal communication via J. Sharp). BEAD assumes these will primarily be losses in the quality of the harvested fruit, based on the type of damage this insect causes.

In Florida, most diazinon use is focused on a complex of armyworm (caterpillar) species. The most common and damaging of these appear to be the fall armyworm (*Spodoptera frugiperda*), southern armyworm (*S. eridania*), and beet armyworm (*S. exigua*) (USDA 1999b).Young larvae mainly damage foliage, though they will also feed on berries to some extent. Larger caterpillars can severely damage the crowns of young plants, thus reducing yield, or reduce the quality of harvested berries by feeding directly on mature berries (USDA 1999a, 1999b).

Use of diazinon in other regions is very low. In North Carolina, diazinon is occasionally used against imported fire ants (*Solenopsis wagneri*), which can sting farm workers and thus hinder harvest and crop maintenance. Chlorpyrifos is available as an effective alternative to this use, and control can also be obtained by pouring hot water on ant mounds (Sorensen, personal communication). In other parts of the Eastern US, diazinon is also recommended for control of the strawberry leafroller (*Ancylis comptana fragariae*) (Gut et al. 2001). This insect rarely causes economic losses, however, and bifenthrin and carbaryl are effective registered alternatives (Gut et al. 2001, Sorensen 2002).

Alternatives currently available for diazinon use against the primary insect pests discussed above are summarized in Table 4. Only those insecticides that BEAD believes should have efficacy or "knock-down" ability similar to that of diazinon are listed, out of a larger list of registered chemicals. "Knock-down" may be defined as the extent to which insects are intoxicated enough to fall off the host plant, as opposed to the ability of a pesticide to kill an insect. An insecticide with good knock-down capability can be combined with another one, biological control agents, or cultural control such as tilling, to reduce pest populations. Even some of those listed below have potentially significant limitations to widespread sustained use, which are discussed in the next section. Note also that growers are not likely to use the same alternative against all pests it is available for, since they will have to ration out applications of each material for different pests which they anticipate will appear.

Table 4. Currently available chemical alternatives to diazinon use against major insect pests of US strawberries.

Insect	Potential Alternatives
Aphids	Malathion[3], methomyl[2], insecticidal soap[4], naled[3]
Lygus bugs	Bifenthrin[1], fenpropathrin[1], malathion[3], methomyl[2], naled[3], insecticidal soap[4]
Armyworms and other caterpillars	Methomyl[2], endosulfan, spinosad[4]

Sources: Sorensen, 2002; Gut *et al.*, 2001; Zalom *et al.*, 2001.

1 Synthetic pyrethroid.

2 Carbamate.

[3] Organophosphate

[4] Reduced-risk chemical.

IMPACTS OF CANCELLATION OF DIAZINON

Pest Management Impacts

For aphid pests, the alternatives listed (Table 3) can all provide adequate control as substitutes for diazinon. However, some potentially significant limitations with almost all the alternatives exist and may result in unpredictable impacts on pest management and the consequent economic impacts. These include: phytotoxicity (for insecticidal soap and naled), short residual activity (for soap and malathion), and perhaps most significant of all, outbreaks of spider mites (for methomyl) (USDA 1999a, Zalom et al. 2001, Sharp, personal communication). Considering these limitations, as well as efficacy aspects, BEAD believes that for aphids, growers will most likely turn to malathion, naled or methomyl in the event of a loss of diazinon.

Methomyl may kill beneficial predatory mites, which could result in outbreaks of phytophagous spider mites. Thus its use would require an additional acaricide application. Several effective acaricides are registered for use on strawberries, including avermectin, dicofol, and bifenazate. It should also be noted that methomyl cannot be used in fields intended for “U-pick” operations where the general public is allowed, and some growers will be reluctant to use it for this reason also. Malathion will have to be applied more often than diazinon since its residual activity is shorter, and will likely only be used where knock-down of high aphid populations is the main objective. Naled will probably be used in cooler weather (and so probably earlier in the growing season) since it is most phytotoxic at higher temperatures (Sharp, personal communication). Scenarios exploring the economic impact of the use of these insecticides as diazinon substitutes are discussed in the section below.

In the case of *Lygus* bugs also, phytotoxicity and short residual activity with some of the alternative insecticides are potential problems. Furthermore, resistance to synthetic pyrethroids is also a problem which may have a good likelihood of occurring, as it has been observed in other crops, which are sometimes grown near strawberries in California (Snodgrass 1996). *Lygus* adults are highly mobile and often migrate between host plants (Zalom et al. 2001). It should also be noted that fenpropathrin, while effective against *Lygus* bugs, is limited in that it can only be applied twice in a growing season, and has a long pre-harvest interval (30 days). Therefore, BEAD believes that growers are most likely to replace diazinon with methomyl (along with acaricides to suppress these secondary pests) or bifenthrin.

For armyworm infestations in Florida, BEAD believes that the most common substitute for diazinon will be either spinosad or methomyl plus an acaricide. Resistance to spinosad in these insects is a problem with some potential, particularly in the southeastern US, where it has been reported in some armyworm populations in cotton (Mascarenhas et al. 1998, Moulton et al. 2000). This is a long term issue that could have potentially severe consequences for pest management in this strawberries, but BEAD cannot reliably predict when this might occur.

While diazinon is not currently used extensively as a soil insecticide in strawberries, it appears that this is the case because of the effectiveness of early-season applications of methyl bromide, which controls grubs and wireworms that could otherwise be potentially devastating pests, particularly in the eastern US

(Aerts, personal communication). This implies that if methyl bromide is permanently removed as a control option, any loss of diazinon as a soil pesticide may have significant negative impact on pest management. In the northeastern US, Japanese beetle grubs are an additional problem not faced in more southern growing regions, for reasons that are presently unclear (Isaacs, personal communication). They are currently of minor concern in strawberries but attack a number of adjacent crops, and could add to the problem soil insects in general pose to eastern strawberries which are more often grown as perennial crops (Isaacs, personal communication).

Economic Impacts

Per-acre Impacts

Crop budgets were obtained from the University of California Cooperative Extension Program (Klonsky and DeMoura, 2001) and the Center of Agribusiness, University of Florida at Gainesville (2001). These budgets are not based on grower surveys, but are representative of typical practices in the states. These budgets do not include costs of specific insecticides, but provide an indication of total expenditures growers are likely to incur. Historical yields and prices, shown in Table 1, were used to calculate gross revenues. For California, average yields are 15.8 tons/acre and the price received is about $1,140/ton, or $0.569/lb. This price includes about 75% of production for the higher value fresh market and 25% for the frozen market. Gross revenues are just under $18,000/acre. Average yields in Florida are about 15.2 tons/acre and growers receive about $1,690/ton, or $0.844/lb, for the winter fresh market. Gross revenues are therefore over $25,500/acre. We focus our assessment on net cash returns or net revenues, which are simply gross revenues less variable operating costs. Production costs do not include fixed and quasi-fixed costs such as land values and infrastructure, including irrigation equipment. Thus, net cash revenue overstates returns to the grower's labor and management skills.

The principal pests targeted by diazinon in California strawberry production are aphids and *Lygus* bugs. Alternatives for aphids include malathion, naled and methomyl. The latter would probably require an additional treatment against mites as it will also reduce the populations of beneficial, predatory insects. Against *Lygus* bugs, growers could also use methomyl, again with an additional treatment for mite control, or bifenthrin, which could be ineffective if resistance occurs. EPA data provide average costs of insecticide applications. Diazinon, usually applied once at a rate of 1 lb a.i./acre, costs about $7.95/acre. Both malathion, at $4.92/acre, and naled, $6.66/acre, at the same rate are cheaper than diazinon, but would have to be applied at least twice to achieve equivalent effectiveness against aphids. The total cost of aphid control would rise by 24-68%. This translates into a negligible increase in total production costs, however, and a decrease in net cash returns of 0.1-0.3%. Table 5 summarizes the impacts of this change.

In the case of *Lygus* bugs, growers could use bifenthrin, but at substantially higher costs. EPA data provides average application costs for bifenthrin, at 0.14 lbs a.i./acre, of $56.76/acre, over six times the cost of diazinon. This represents a 7.3% increase in insecticide costs and a 0.3% increase in total operating costs. Net cash revenues fall almost $50/acre or 2.7%. If the *Lygus* bugs were to be resistant to the synthetic pyrethroid, severe damages could result. BEAD assumes that the 35% loss noted above refers

Table 5. Gross returns, production costs and net cash returns with treatment for aphids in California strawberries.

	Base Scenario diazinon	Alternative malathion	% Change	Alternative naled	% Change
production (tons/acre)	15.8	15.8	0.0	15.8	0.0
price ($/ton)	1140.00	1140.00		1140.00	
gross revenues	17,968.00	17,968.00	0.0	17,968.00	0.0
diazinon	7.95				
malathion		9.84	23.8		
naled				13.32	67.5
other insecticides	663.00	663.00		663.00	
total insecticide costs	671.00	673.00	0.3	676.00	0.8
other pre-harvest costs	6,892.00	6,892.00		6,892.00	
harvest costs	8,607.00	8,607.00		8,607.00	
total operating costs	16,170.00	16,172.00	0.0	16,175.00	0.0
net cash returns	1,798.00	1,796.00	-0.1	1,792.00	-0.3

Source: University of California Cooperative Extension, 2001, BEAD data.
All units are in $/acre unless otherwise noted. Totals may differ from the sum of components due to rounding.

to a quality shift from the fresh market to the frozen market and essentially results in a drop in the average price received. With just under 50% of production of sufficient quality to meet fresh market standards and the rest going to the frozen market, BEAD calculates an average farm gate price of $932/ton, a decrease of 18%. To the extent that the frozen market also demands relatively high quality, unmarked fruit, this may understate the damage to growers. Coupled with the increase in insecticide costs and only slightly offset by a decrease in harvest costs[1], growers would face negative net returns. Table 6 provides a summary of these figures.

Both aphids and *Lygus* bugs could occur simultaneously, requiring growers to use both bifenthrin

[1]Harvest costs include an assessment by the marketing board, which is somewhat lower for frozen than for fresh quality fruit.

Table 6. Gross returns, production costs and net cash returns with treatment for *Lygus* bugs in California strawberries.

	Base Scenario diazinon	Alternative: bifenthrin			
		no resistance	% Change	with resistance	% Change
production (tons/acre)	15.8	15.8	0.0	15.8	0.0
price ($/ton)	1140.00	1140.00	0.0	932.00	-18.1
gross revenues	17,968.00	17,968.00	0.0	14,721.00	-18.1
diazinon bifenthrin	7.95	56.76	614.0	56.76	614.0
other insecticides	663.00	663.00		663.00	
total insecticide costs	671.00	720.00	7.3	720.00	7.3
other pre-harvest costs	6,892.00	6,892.00		6,892.00	
harvest costs	8,607.00	8,607.00	0.0	8,284.00	-3.7
total operating costs	16,170.00	16,219.00	0.3	15,896.00	-1.7
net cash returns	1,798.00	1,749.00	-2.7	-1,176.00	-165.4

Source: University of California Cooperative Extension, 2001, BEAD data.
All units are in $/acre unless otherwise noted. Totals may differ from the sum of components due to rounding.

and either malathion or naled, increasing total costs of controlling both pests by $59-62/acre. Methomyl, however, offers the same broad spectrum control as diazinon, but would probably interrupt biological controls of mites and require an additional treatment with an acaricide. With an average costs of $19.03/acre at 1.0 lb a.i./acre, methomyl is more expensive than either malathion or naled, but less than bifenthrin. The average cost of mite control in California is $51.23, according to EPA data. This results in an overall increase in insecticide costs of about 9.3%, more than bifenthrin alone. However, methomyl would offer control over both pests without risk of damage from resistant insects, making it a more likely alternative. Costs and returns are summarized in Table 7. The additional insecticide costs would result in losses of about $62/acre or 3.5% of net revenues.

In Florida, diazinon for control of armyworm will likely be replaced by spinosad or by methomyl and an additional treatment for mites. Production costs and returns for this scenario are shown in Table

Table 7. Gross returns, production costs and net cash returns with treatment for aphids and *Lygus* bugs in California strawberries.

	Base Scenario diazinon	Alternative methomyl + acaricide	% Change
production (tons/acre)	15.8	15.8	0.0
price ($/ton)	1,140.00	1,140.00	
gross revenues ($/acre)	17,968.00	17,968.00	0.0
diazinon ($/acre) methomyl ($/acre)	7.95	 19.03	 139.4
other insecticides ($/acre)	663.00	714.00	7.7
total insecticide costs ($/acre)	671.00	733.00	9.3
other pre-harvest costs ($/acre)	6,892.00	6,892.00	
harvest costs ($/acre)	8,607.00	8,607.00	
total operating costs ($/acre)	16,170.00	16,232.00	0.4
net cash returns ($/acre)	1,798.00	1,735.00	-3.5

Source: University of California Cooperative Extension, 2001, BEAD data.
All units are in $/acre unless otherwise noted. Totals may differ from the sum of components due to rounding.

8. Diazinon is applied at a rate of 0.5 lbs a.i./acre about four times throughout the season at a cost of $4.20/acre for each application. Spinosad is applied at about 0.08 lbs a.i./acre at an average cost of $19.48/acre. Methomyl, at 0.5 lbs a.i./acre, costs an average of $10.58/acre. We assume the alternatives will also have to be applied four times during the growing season. Further, the average cost of an acaricide application is $39.47/acre. Cost increases are similar for the two alternatives. Spinosad would cost an additional $61/acre while methomyl and one acaricide treatment costs an additional $64.99/acre. If more than one treatment for mites were necessary, this cost would increase. The extra costs reduce net revenues by less than one percent.

Industry Level Impacts

State level impacts are simply calculated by multiplying the per-acre impacts by the number of acres affected. From Table 3, we note that about 3,300 acres in California and 700 acres in Florida are currently treated with diazinon. Costs of cancellation could be about $62/acre in California, assuming replacement of diazinon with methomyl, and $61/acre in Florida, given use of spinosad. Total costs to the strawberry industry could be nearly $250,000 out of a gross value of over $1 billion, or 0.02%. These results are summarized in Table 9. While diazinon use is slight in other producing states, some impacts of a cancellation would be felt there as well.

Table 8. Gross returns, production costs and net cash returns with treatment for armyworm in Florida strawberries.

	Base Scenario diazinon	Alternative spinosad	% Change	Alternative methomyl + acaricide	% Change
production (tons/acre)	15.2	15.2	0.0	15.2	0.0
price ($/ton)	1690.00	1690.00		1690.00	
gross revenues	25,573.00	25,573.00	0.0	25,573.00	0.0
diazinon	16.80				
spinosad		77.92	363.8		
methomyl				42.32	151.9
other insecticides	478.70	478.70	0.0	518.00	8.2
total insecticide costs	496.00	557.00	12.3	560.00	13.1
other pre-harvest costs	4,918.00	4,918.00		4,918.00	
harvest costs	11,610.00	11,610.00		11,610.00	
total operating costs	17,024.00	17,085.00	0.4	17,089.00	0.4
net cash returns	8,550.00	8,489.00	-0.7	8,485.00	-0.8

Source: Center of Agribusiness, University of Florida, 2001, BEAD data.
All units are in $/acre unless otherwise noted. Totals may differ from the sum of components due to rounding.

Table 9. Industry level impacts of a cancellation of diazinon on strawberries.

State	Acres Impacted	Cost/Acre	Total Cost
California	3,300	$62.00	$204,600
Florida	700	$61.00	$42,700
Total	4,000		$247,300

Source: BEAD calculations.

CONCLUSION

Diazinon is mainly used on strawberries as a foliar application for control of aphids and *Lygus* bugs in California and against armyworms in Florida, with minor usage in other states. Alternatives for control exist, although they are more costly. The most likely alternative in California is methomyl, as it provides control over both pests and is not likely to face problems of resistance. However, it will require adjustment in the pest management program, since it will kill beneficial predatory insects that otherwise control mites, and has restrictions preventing use in "U-pick" operations. Costs are expected to increase about $62/acre, lowering net revenues about 3.5%. In Florida, spinosad or methomyl, with an acaricide, could be used to replace diazinon, with per-acre costs similar to California, representing less than one percent of net revenues.

Total costs to the strawberry industry in these two states could be around $250,000 with most of the costs borne by California growers.

While rarely used against soil pests, diazinon may be called upon to play an important role in control of these pests as restrictions on methyl bromide are put into place.

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